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EXPERIMENTAL RESEARCH IN SMAW PARAMETER TO MINIMIZE THE RESIDUAL STRESS AND ANALYSIS FOR ELIMINATE COLD CRACKS

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ABSTRACT

In a perfect earth all materials would match thro-ugh being without error, together in their mechanical and chemical structure. It would definitely make simpler welding, especially when choosing filler materials. So far in several applications it is essential to weld metals with dissimilar strengths. Through performing like that you can decrease material expenditures and use materials that are well fitted to the final service environments of the finished part. The dispersal of the residual stress in the welded joint of high strength steel was reconnoitred through finite element technique by means of ANSYS software. Welding was performed using shielded metal arc welding with different heat input parameters. The FEM study on the weld joint make known that there is a stress gradient nearby the fusion region of weld joint. The rapid residual stress on the weld surface vigour up to 750-900mpa and it is 550-650mpa beneath the weld. The stress gradient close the fusion is greater than any other places in the adjacent zone. This is accredited as one of the important cause for the enlargement of cold crack in the fusion zone of high strength steel. In order to evade such welding cracks, the thermal stress in weld joint has to be reduced by directing the welding heat input parameters.

***KEYWORDS:** Arc Welding, Plate, Residual Stress, Heat Input, EN 8, EN 19 & Cold Cracks*

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Original Article

INTRODUCTION

Residual stresses due to welding arise from the differential heating of the plates by the weld heat source, the resulting non uniform plastic deformation and the cooling that accompanies welding processes. During welding the work piece is subjected to considerable local heating, while immediately after welding, rapid cooling follows, on heating, the metal expands and cooling products contraction. One of the major serious defects in welding is cracks. Cracks are linear parting of the material under stress. Occasionally they seem large and regularly they are thin partings. Welding is an olden art of joining metals together which produces a stable, integrally very strong joint that cannot be complemented with any other joining techniques. As welding has become more technologically oriented, highly accurate automatic welders, laser welders and electron beam welders have emerged increase in speed and versatility of welding. Such developments make it an exciting time to join the welding industry The Flat position welding elaborate fixtures have been designed to rotate the work so to accomplish welding in flat position. This position is most popular as it requires least skill for producing the sound bead. In the precise intellect of the word, a defect is a unacceptable discontinuity or a flaw of unacceptable type. Definite flaws are acceptable in one kind of manufactured article. A defect is certainly a discontinuity, but a discontinuity may not be certainly a defect. Acceptance or rejection of flaws is based on different factors. The significance of weld quality is progressively felt as we are manufacturing of very critical products by means of higher strength materials combined with critical design requirements. Nevertheless, defects are expected to be existent in materials manufactured at economic price.

To find out the proper heat input for minimize the cold crack and residual stress. To increase the mechanical properties and minimization of metallurgical defects for arc welded EN 8 and EN19 Material.

To measure=> Heat input

To minimise=> Metallurgical defects (cold crack) Residual stress

To maximize=> Mechanical properties

RELATED WORK

[1]In different steel making industries which has to do with ship-building and high rate of motion train guide way, the key and significant Issue of residual and distortion was there. So a Finite Element Analysis observation on residual stresses which happens after welding process in material is studied in this editorial. Dispersal of residual stresses which rises after welding is pretty complex. Shielded Metal Arc Welding (SMAW) which is also identified as Manual Metal Arc Welding is used for this research and in this welding process steel temperature field is increased.

In various fields welding has substituted by riveting and casting methods. Because of the high temperature presented for the duration of welding and succeeding cooling of weld metal, welding can create uninvited residual stress and the distortion on the part. It is significant curiosity to simulate the process of welding to define the confirming the residual stress and distortion and forecast the performance of welded constructions. The present effort emphases on calculation of the maximum stress, displacement, strain for bent plates being welded and as well the deformation due to the temperature difference is to be premeditated. To perform this type of activity the software similar to Solidworks for modelling and ANSYS for analysis of the welded joint is utilized. It can be determined that the welding travel speed and heat input has a significant retort on the weldment. The price acquired for the investigational set up, testing and analyzing is reduced with the stated effort. [2]

The finite element study of residual stresses in butt welding of two alike plates is executed with the ANSYS software. This study consists of a finite element model for the thermal and mechanical welding simulation. It also contains a non-fixed movable heat source, metal deposit, temperature reliant on material properties, material plasticity and elasticity, transient heat transfer and mechanical analysis. The welding virtual reality was considered as a consecutive together thermo-mechanical analysis and the element birth and death technique was used for the simulation of filler metal deposition on the weld joint. The residual stress dissemination and extent in the axial direction is to be obtained. A respectable agreement among the computation and investigational outcomes is to be obtained [3].

MATERIAL SPECIFICATION

Chemical Composition

En8: Unalloyed medium carbon steel

New Name: 080M40

Designation: BS970 080M40.

EN stands for ‘Euro-Norm’

Table 1: Chemical Composition of EN8

Composition				
C.	**Si.**	**Mn.**	**S.**	**P.**
0.35-0.45%	0.05-0.35%	0.6-1.0%	0.03%	0.03%

En19: High tensile alloy steel

New Name: 709M40 Designation: BS970 709M40

Table 2: Chemical Composition of EN19

Composition				
C.	**Si.**	**Mn.**	**Cr.**	**Mo.**
0.40%	0.25%	0.70%	1.20%	0.30%

EXPERIMENTAL ANALYSIS

Low alloy steel comprising minor quantities of alloying elements Cr, Mo, Si, Mn and Ni. The specified value of tensile strength of this steel is 1300 MPa and this steel reveals respectively high hardenability. The microstructure of EN8 & EN19 steel contains low carbon, tempered martensite and has a wide range of properties after heat treatment. The length of the weld plate was 100 mm, width 80mm and the thickness was 12 mm. The test plate was welded using shielded metal arc welding (SMAW). Low strength filler rod (Electrode) was used for welding (Composition of E7018 electrode AWS: C 0.15%, Si 0.75%, Mn 1.60%, Mo 0.30%, Ni 0.30%). If high strength welding consumables are utilized, then It is essential to preheat the weld plate to eliminate cracks throughout welding. Three set of test sample pieces of EN 8 and EN 19 prepared and welded with change in Amps from 150Amps, 175Amps & 200Amps maintaining all other parameters same in order to find the optimum heat input to reduce the residual stress.

Program of the Finite Element Calculation

Analysis of weld joint consists of two parts in finite element analysis. (a) Thermal cycle calculation and (b) Instantaneous stress calculation. A set of instruction was written to compute the thermal cycle. The same set of instruction can also be used to compute the non-linear heat conduction in the weld metal zone. The following parameters were used in the set of instruction (a) thermo-physical parameters like (b) Specific heat (c) coefficient of linear expansion (d) thermal cycle and (e) coefficient of thermal conductivity. After the welding completed, the information to determine thermal field and thermal cycle were recorded.

Meanwhile the weld sample engaged for analysis was symmetrical and the weld centre was at the symmetry axis. Exactly half of the weld section was taken for investigation. $x = 0$ corresponds to the symmetry axis. As of the non-uniformity of the stress filed and weld temperature field, the heat affected zone and the weld metal were refined locally and the region beyond the weld metal was coarsened progressively in the mesh division for further precise results.

The fusion zone under the different heat input parameter conditions of the thermal cycles of welding are shown in figures. The heat disperses from the weld plate to the surrounding by radiation and convection because of the thermal gradient among the weld plate and the surrounding atmosphere.

The foundation of the finite element technique is to convert the non-linearity relation of the strain and stress into a linear one during the loading process. In welding the peripheral energy does not have any effect. However, loading is because of the variation in temperature. The technique to overcome this issue is to calculate the percentage increase of the

load with variation in temperature, T, and then sum up these to the structural elements. The free boundary conditions and the centre axis was symmetrical were presumed.

The finite element study of the thermal elastic-plastic stress was performed with ANSYS software. The element was divided into many finite elements as initial step. The distribution of the thermal field of welding was found by entering the thermo-physical parameters. The induced stress field due to welding is determined. By means of the non-linear instantaneous stress investigation, heat and structure part were combined in the calculation. Due to change in temperature, the mechanical parameters and thermo-physical parameters change. For easy application, the parameters such as specific heat, density, coefficient of linear expansion and coefficient of heat conductivity were concluded considering a linear change in temperature.

EDGE Preparation

To obtain sound welds, good edge preparation is particularly essential, consisting in suitably levelling the edges, and carefully cleaning the faces to be welded from dust, sand, grit, oil and grease. Different edge preparation is particularly used in fusion welding process for welding butt joints are square, Single ’V’, Double ’V’, Single ’U’ and Double ’U’.

The preparation of edges depends upon the thickness of metal being welded. Square butt weld may be used for thickness from 3 to 5 mm. Before welding the edges are spaced from 3mm apart.

Single ‘V’ butt welds are frequently used for metal over 8mm and up to about 16 mm thick. The edges forming the joint are levelled to form an included angle to 70 to 90 degree depending upon the welding technique to be used. Double ‘V’ butt welds are used on metals over 16 mm thick and where welding can be performed on both sides of the plate. Single and double ‘U’ butt welds are used on metals over 20 mm thick they are most satisfactory and require less filler rod but they are difficult to prepare.

Table 3 Welding Grove details

STRUCTURE	THICKNESS
Square	3 to 5mm
Single ‘V’ groove	8 to 16mm
Double ‘V’ groove	above 16mm
Single & double ’U’ groove	above 20mm

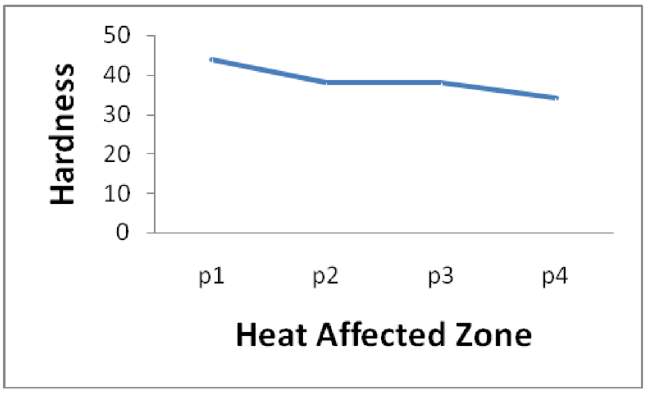
RESIDUAL STRESSES IN WELDS

Residual stresses due to welding arise from the differential heating of the plates by the weld heat source, the resulting non uniform plastic deformation and the cooling that accompanies welding processes. Stresses in welds are produced due to

- Hindered expansion and contraction of the heated METAL due to the piece being welded it self (mechanical residual stresses)
- Phase a transformation which takes place while cooling from, above the austenizing temperature (metallurgical residual stresses)
- Restraint to thermal expansion and contraction offered by other parts of the structure to which the piece being welded is attached (reaction stresses)

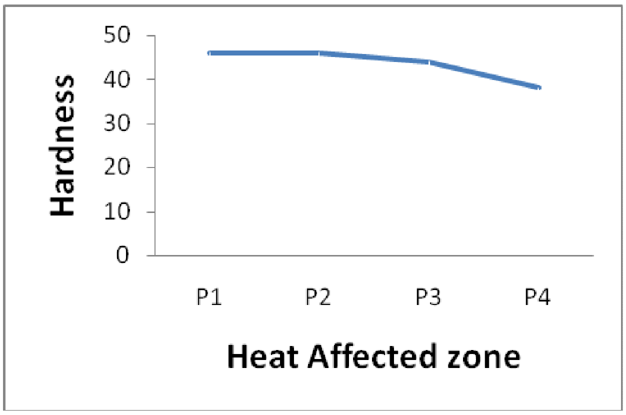
HARDNESS TEST

EN8 150 AMPS - HEAT AFFECTED ZONE VS HARDNESS



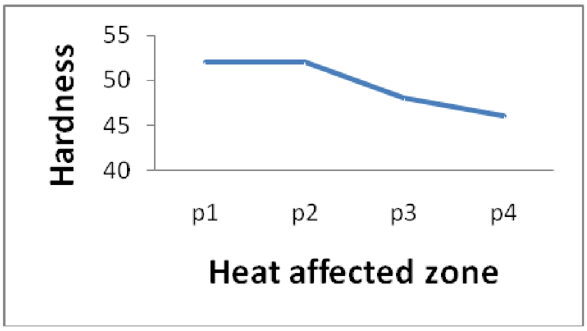
Graph 1: HAZ Hardness of EN 8 – 150 Amps

EN8 175 Amps - HEAT AFFECTED ZONE Vs HARDNESS



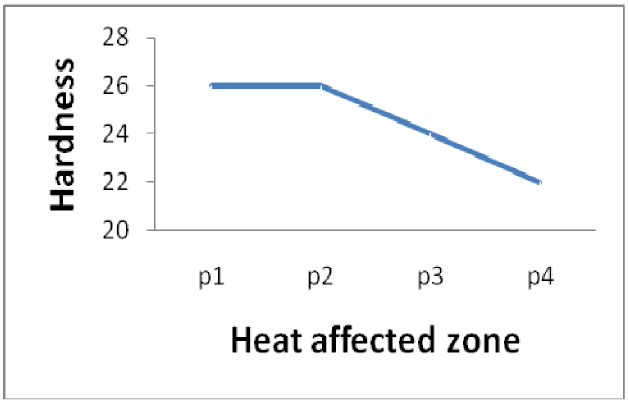
Graph 2: HAZ Hardness of EN 8 – 175 Amps

EN8 200 AMPS - HEAT AFFECTED ZONE VS HARDNESS



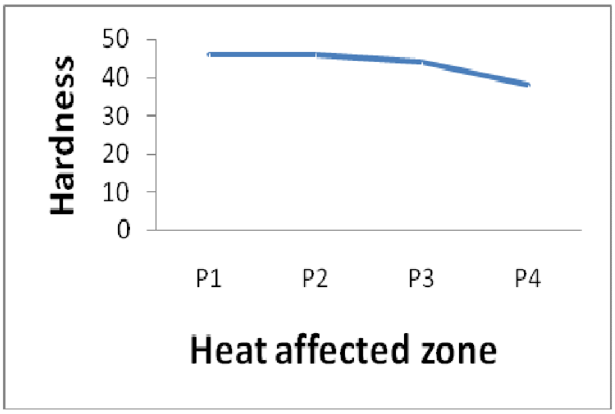
Graph 3: HAZ hardness of EN 8 – 200 Amps

EN19 150 AMPS - HEAT AFFECTED ZONE VS HARDNESS



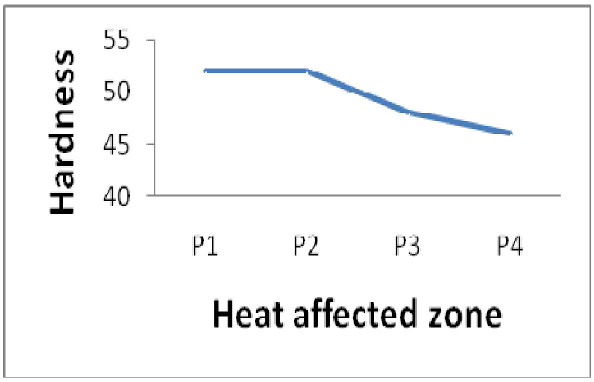
Graph 4: HAZ Hardness of EN 19 – 150 Amps

EN19 175 AMPS - HEAT AFFECTED ZONE VS HARDNESS



Graph 5: HAZ hardness of EN 19 – 175 Amps

EN19 200 AMPS - HEAT AFFECTED ZONE VS HARDNESS



Graph 6: HAZ hardness of EN 19 – 200 Amps

FINITE ELEMENT MODELING

EN 8 - STRESS DISTRIBUTION IN FUSION ZONE AT 150 AMPS

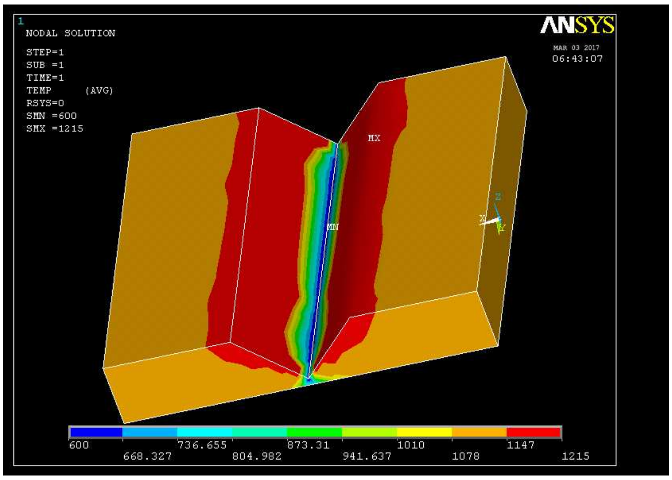


Figure 1: Stress Distribution of EN 8 – 150 Amps

EN 8 - STRESS DISTRIBUTION IN FUSION ZONE AT 175 AMPS

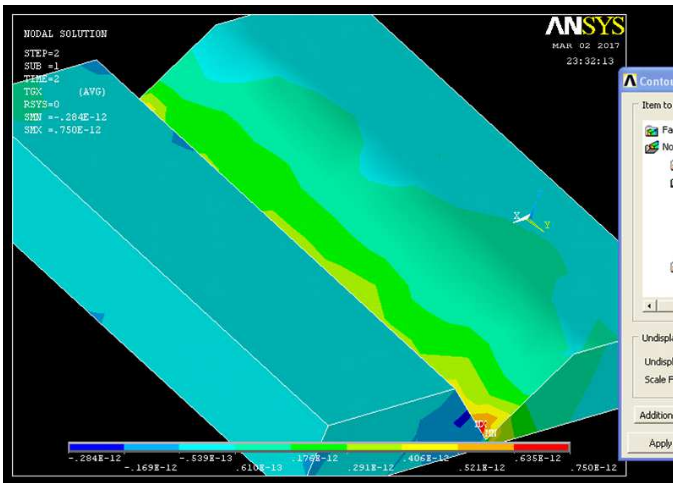


Figure 2: Stress Distribution of EN 8 – 175 Amps

EN 8 - STRESS DISTRIBUTION IN FUSION ZONE AT 200 AMPS

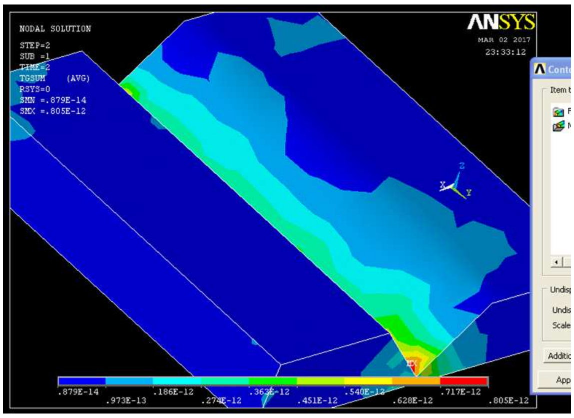


Figure 3: Stress Distribution of EN 8 – 200 Amps

EN 19 - STRESS DISTRIBUTION IN FUSION ZONE AT 150 AMPS

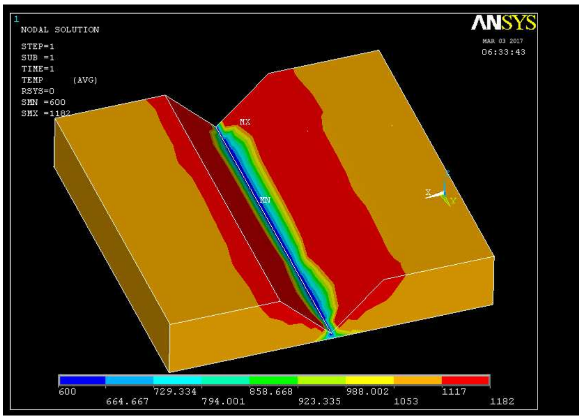


Figure 4: Stress Distribution of EN 19 – 150 Amps

EN 19 - STRESS DISTRIBUTION IN FUSION ZONE AT 175 AMPS

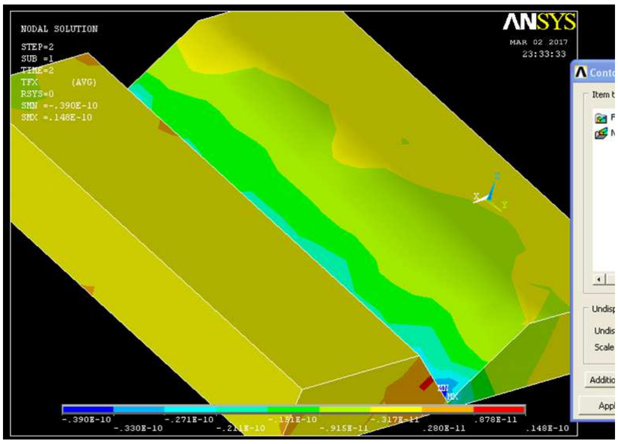


Figure 5: Stress Distribution of EN 19 – 175 Amps

EN 19 - STRESS DISTRIBUTION IN FUSION ZONE AT 200 AMPS

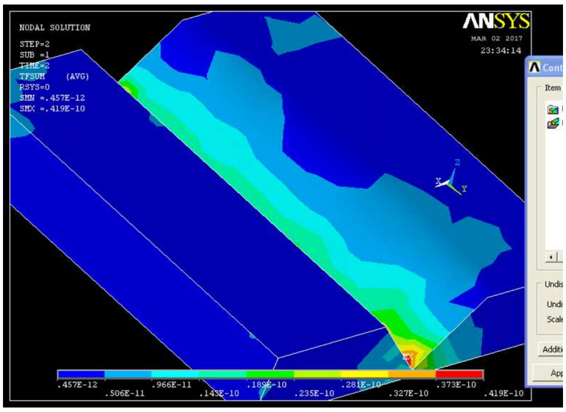


Figure 6: Stress Distribution of EN 19 – 200 Amps

RESULTS AND DISCUSSIONS

The stress value is maximum of 175 Amps and 200 Amps welding current and that also will lead to the higher value of residual stress. Hence 150 Amps is found to be the optimum value for the Arc welding of EN8 and EN19 material. The investigational outcomes expose that there is a stress gradient all over the place of the fusion zone. The instant stress on the weld surface is 750-900 MPa and under the weld is 550-650 MPa. The obtained value is high close the fusion zone and this is one of the causes for the creation of cracks in the fusion region in high strength steels. So we conclude that the optimum heat input for the welding of EN8 and EN19 material is 150 Amps. The experimental results reveal that there is a stress gradient around the fusion zone.

CONCLUSIONS

Non Destructive Testing like Ultrasonic testing, penetrant and visual testing performed on the welded plates and the test results revealed that no cracks found on the welded areas. Hardness test results value found on the welded test plates as less values in the low heat input welded plate of parameters 150 Amps. The distribution of the residual stress in the weld/zone of steel was determined using ANSYS finite element software. After conducting the UT test and hardness test the optimum heat input of 150 Amps is suggested for reducing the stress. This project is mainly aimed for the improvement of weld metal properties of EN8 and EN19 material by optimizing the welding parameters.

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